Center Independent Research & Development: JPL IRAD

Underwater Mobile Manipulation (UMM)

Completed Technology Project (2015 - 2018)

Project Introduction

The Underwater Mobile Manipulation project will develop and demonstrate key elements of an underwater robotics system that can provide unprecedented levels of perception and manipulation that will meet the challenges of the offshore energy sector. This objective will be met by developing an advanced perception suite for underwater manipulation and adapting the dexterous robotic manipulation technology suite demonstrated on the DARPA Robotics Challenge (DRC) RoboSimian robot for underwater applications.

The Underwater Mobile Manipulation project will perform technology development in the areas of perception, robotic limb hardware and robotic limb control in order to develop a subsea automated manipulation system. This development will build on capabilities demonstrated on other JPL limbed robotic platforms such as the Curiosity Rover, ATHLETE, and RoboSimian. The Underwater Mobile Manipulation robotic system will consist of a perception suite, 7 degree of freedom robotic limb and associated perception and control software. The perception suite includes color stereo cameras in dome-port underwater housings, a 2D imaging sonar, a variable illumination underwater light and a pan-tilt mount. Fused opti-acoustic point clouds will be created from these instruments using JPL stereo vision and sensor fusion techniques and acoustic image processing techniques described in literature. The robotic limb will be adapted from the modular limb design used by RoboSimian. Each joint will employ the same high power-density harmonic geared actuator. Actuator control electronics will reside in the actuator housings. The limb will incorporate a 3 DOF gripper based off of the RoboSimian CAMHand. On both the limb actuators and gripper, traditional o-ring and spring-energized sealing approaches will be used to seal the air-filled housings to 30m depth. To control the limb we will adapt the high DOF motion planning from ATHLETE and RoboSimian which make use of distributed, networked motor control components. Semi-autonomous manipulation behaviors will be developed by parameterizing behaviors to chain together sets of arm motions while monitoring end-effector force measurements. Scene reconstruction products, such as targets or collision volumes, will act as inputs into behaviors.

Anticipated Benefits

This technology project will develop and demonstrate needed automated robotic manipulation capabilities in the area of energy sector subsea operations. The capabilities developed in the this technology project could be applied to reducing operation risk and intervention duration in cases of catastrophic oil leaks initiated subsea.

Project Image Conceptual Artist Image of a Subsea Limbed Robot

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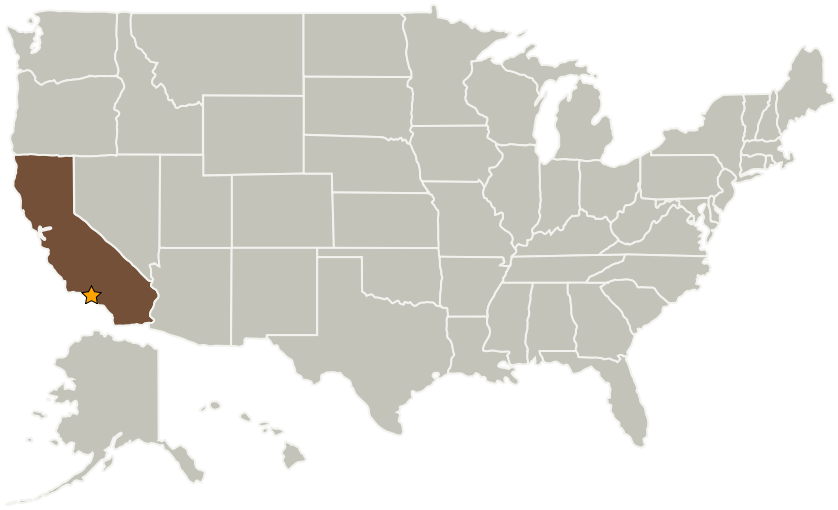
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Independent Research & Development: JPL IRAD

Project Management

Program Manager:

Fred Y Hadaegh

Project Manager:

Fred Y Hadaegh

Principal Investigator:

Matthew L Gildner

Co-Investigators:

Renaud J Detry
Michael S Garrett
Peter T Godart
Justin R Koch

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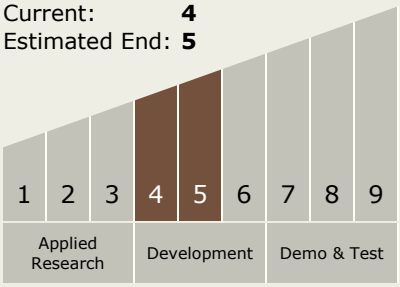
Images

UMM_Subsea_Limbed_Robot.jpg
Project Image Conceptual Artist Image of a Subsea Limbed Robot
(https://techport.nasa.gov/image/26099)

Technology Maturity (TRL)

Start: **4**
Current: **4**
Estimated End: **5**



Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.3 Manipulation
    - TX04.3.1 Dexterous Manipulation

Target Destinations

Earth, Foundational Knowledge

Supported Mission Type

Push